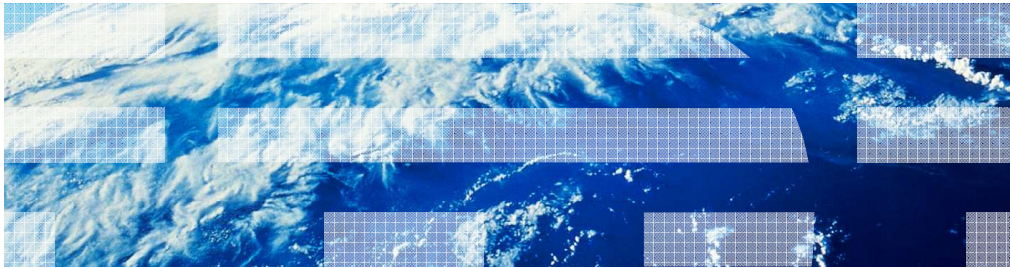


# IBM WebSphere Application Server Feature Pack for OSGi Applications and Java Persistence API 2.0

## *Java Persistence API 2.0 overview*



This presentation will introduce Java™ Persistence API in general and some of the JPA 2.0 features shipped in the feature pack.

## Table of contents

- Brief introduction to Java Persistence API (JPA)
- JPA 2.0 Feature Pack overview
- OpenBooks sample program description

This presentation contains a brief introduction to the Java Persistence API, an overview of what is in the JPA feature of the IBM WebSphere® Application Server Feature Pack for OSGi Applications and Java Persistence API 2.0, and a description of a sample program available on the web that you can try.

## What is JPA? (1 of 2)

- Standard persistence technology
  - JPA 1.0 introduced in Java EE 5
  - JPA 2.0 is part of Java EE 6 standards
  - Object/Relational Mapping
  - Designed for highly distributed applications
    - Especially web-enabled applications
  - Life cycle manageable by application server to increase quality of service
- Simplifies development
  - Provides a framework and tools around providing automatic persistence
  - Objects are mapped to tables using metadata
    - Metadata is used to transform data from one representation to another

Here are some of the general JPA concepts. JPA 1.0 was introduced back in Java EE 5. WebSphere Application Server has had a couple of releases supporting that, starting with the EJB3 feature pack for WebSphere Application Server Version 6.1 and the support was rolled into Version 7. JPA 2.0 is the next iteration of that specification.

JPA provides a lot of functions, but one of the most important is the object mapping capability. If you are familiar with JDBC or CMP Beans or another older technology, then you are likely to see object to relational mapping as a difficult task. JPA provides the capability to do that mapping much easier and in such a way that it is much more applicable to object oriented programmers. JPA greatly simplifies development because it uses standardized metadata to map the objects to the tables. There are standardized mechanisms for accessing these entities whether they are being persisted or queried against. There is now a common query language that can be used. Many aspects of JPA are now standardized and therefore portable so moving between vendors is easier than it was in the past. For example each provider had their own implementation for CMP beans and they were different so moving from one provider to another was very difficult.

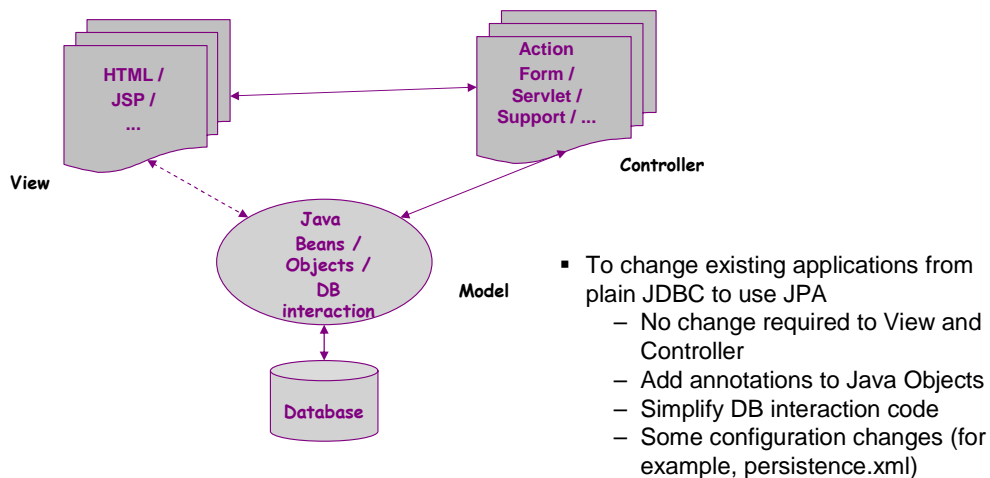
## What is JPA? (2 of 2)

- JPA specifications made very significant simplifications:
  - Standardizes O/R mapping metadata (not the case for EJB 2)
  - Java SE 5.0 annotations can be used instead of XML deployment descriptor
  - No deploy code implementing abstract classes— Entities are POJOs
  - Application server is not required
    - The Java Persistence API is available outside of containers
    - Unit testing greatly simplified
  - Removal of checked exceptions (for instance, remote exceptions)
  - No bean (or business) interface required

The first JPA, which was shipped with Java EE 5, used the annotation support that was part of Java SE 5. Your metadata can be specified either using annotations, which are very intuitive and natural for programmers, or it can be done in XML so you have more control over how you want the mapping without having to change the code.

One thing to highlight on this slide is that an application server is not required in order to reap the benefits of JPA. JPA is fully functional in a JSE mode. That aids development because developers can test their mapping to the database without needing an application server to do it. Once your database interaction is tested and modified to your liking you can bring it into your application in the model-view-controller type model.

## Web application example – MVC framework



On this slide you see the Model View Controller model. One of the key things is that you want to separate your database actions (Model) from the rest of your application. That is where JPA comes into play because it can be done completely separate from the rest of your application. Presentation code goes in the View and your business logic in the Controller.

## Annotate entity object class

The diagram illustrates the code for a JPA entity class named `Client`. It includes three callout boxes with red arrows pointing to specific parts of the code:

- Import the javax.persistence packages:** Points to the `import javax.persistence.*;` line.
- Declare the class as an entity:** Points to the `@Entity` annotation above the class declaration.
- Identify a property as a primary key:** Points to the `@Id` annotation above the `int ID` property.

```
import javax.persistence.*;

@Entity
public class Client {

    @Id
    @GeneratedValue(strategy=GenerationType.AUTO)
    private int ID;

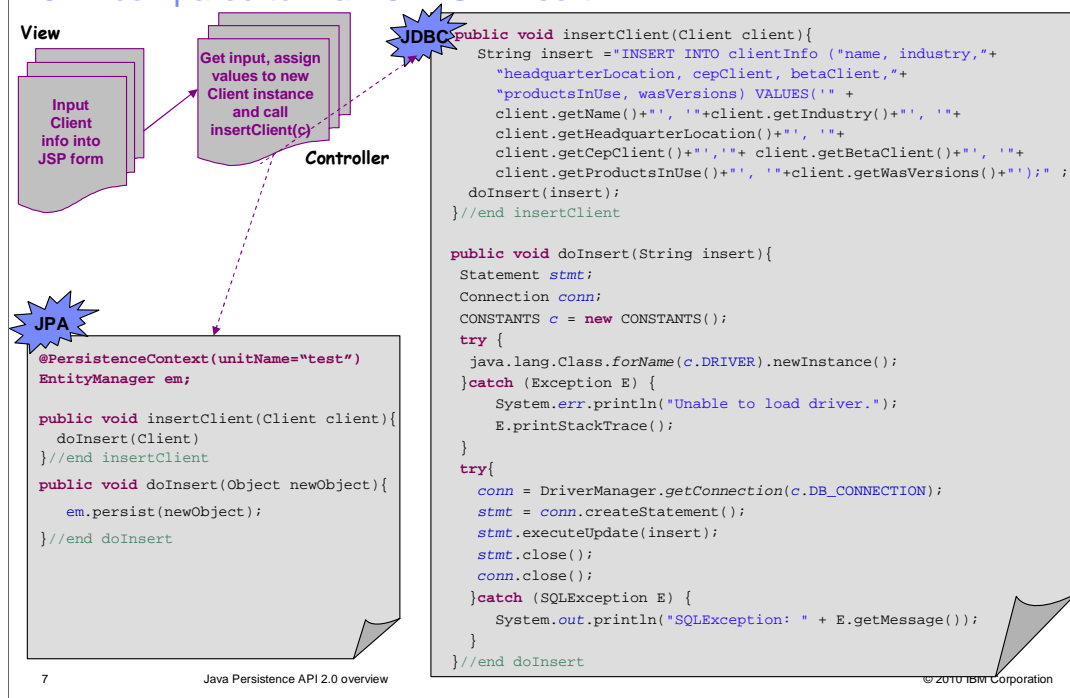
    private String name;
    private String industry;
    private String headquarterLocation;
    private String cepClient;
    private String betaClient;
    private String productsInUse;
    private String wasVersions;

    public Client() {
        ...
    }

    //all necessary getter and setter methods
    ...
}
```

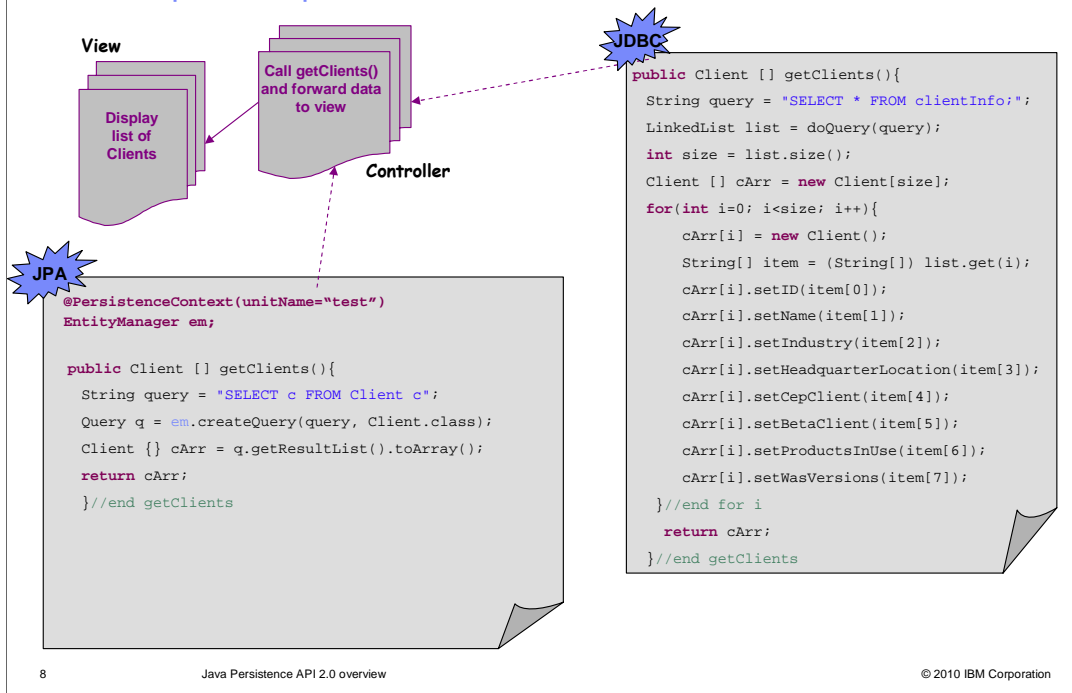
This chart shows a very basic view of a JPA entity. Note here that there are two things required to have a JPA entity: the `@Entity` annotation and the `@ID` annotation. Both are necessary to show that this is an entity within the JPA specification terminology. This is what maps to rows in your table. The columns of your table are identified here by the properties of this entity. The `@ID` annotation defines your table's primary key.

## JPA compared to Plain JDBC – Insert



This chart shows some differences in JDBC and JPA. As the WebSphere team has been learning over the past few releases with WebSphere many users are still using JDBC. Now with JPA you do not need to deal with all of the complexities you have been dealing with using JDBC. You do not need to know SQL or how to parse results from SQL; the JPA runtime does all of that for you. In the lower left corner note that the Client object here is a Plain Old Java Object (POJO). In order to write it to the database one updates the attributes of the object then persists the object. All of the data held in the attributes of the POJO are transferred to the data base without you having to write SQL. The attributes in your POJO correlate to columns in your database table.

## JPA compared to plain JDBC – Retrieve



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Java Persistence API 2.0 overview

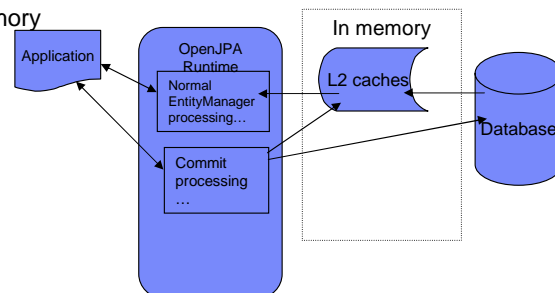
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This page shows a retrieval example. It is no longer necessary to issue an SQL statement to fetch a bunch of rows then to parse the returned data and load it into an object. In the code snippet in the lower left corner you can see the JPQL statement necessary to populate the Client object from the database. The JPQL query language is at the object level and JPA takes care of the database interaction. Again, the attributes of the POJO correlate to columns in your database table. Compare this to the code to the right required to perform the same action using JDBC.



## Advantages to using OpenJPA

- Object level programming model
  - More natural for programmers
- Container “free”
  - No requirement on an application server
  - JEE, JSE, and now OSGi
- Common programming model across databases
  - No database-specific SQL or JDBC
- Ability to Cache database records in memory
  - Fewer trips to the database



This discussion has been talking about programming at the object level and taking advantage of JPA's ability to do object mapping. Perhaps there are programmers in your shop who specialize in database interaction but the more natural way for most programmers is to write code is at the object level. JPA allows database interaction directly from there.

The concept of being container free means that JPA can be used even without an application server of any type, though JEE, JSE, and OSGi are supported.

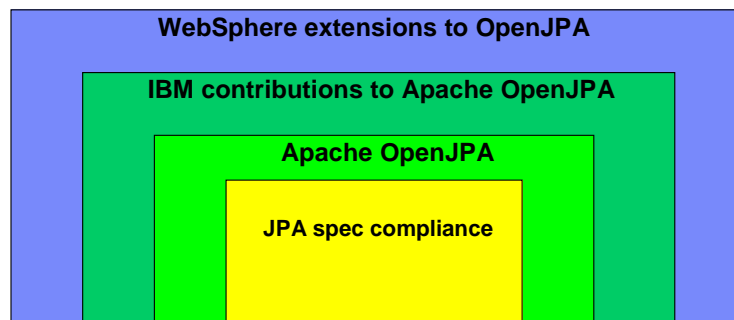
There is no need to use database specific SQL or JDBC, making code more portable.

JPA also provides some memory caching of records so you do not have to go out to the database for every retrieval. This holding data in L2 cache improves performance.

Thus ends the summary of OpenJPA in general.

## WebSphere's JPA Architecture

- WebSphere's JPA Solution
  - Spec Compliant
  - Feature Rich
  - Extensible
  - Competitive with Hibernate and EclipseLink
  - Production Ready



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Java Persistence API 2.0 overview

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This chart shows the relationship between OpenJPA and WebSphere's JPA solution. Starting with Apache OpenJPA and of course it is Spec Compliant. IBM has added enhancements and performance improvements, debugging ability and logging that have been donated to Apache. IBM has a vibrant community in Apache. Most of the development team members are committers on the Apache OpenJPA project, several are on the project management committee, so IBM is very involved in the Apache OpenJPA project. The team continually contributes bug fixes, features, performance improvements, test cases, and documentation updates to the project.

On top of what IBM contributes to Apache then for the WebSphere offering IBM has the value add of integration with key IBM and WebSphere stack products like DB2® and WebSphere eXtreme Scale. Also added are extended logging and translated messages in all of the languages supported by WebSphere Application Server. The WebSphere Application Server JPA 2.0 feature is production ready with full IBM support.

## ***JPA 2.0 Feature Pack overview***

Now, an overview of what is in the Feature Pack.

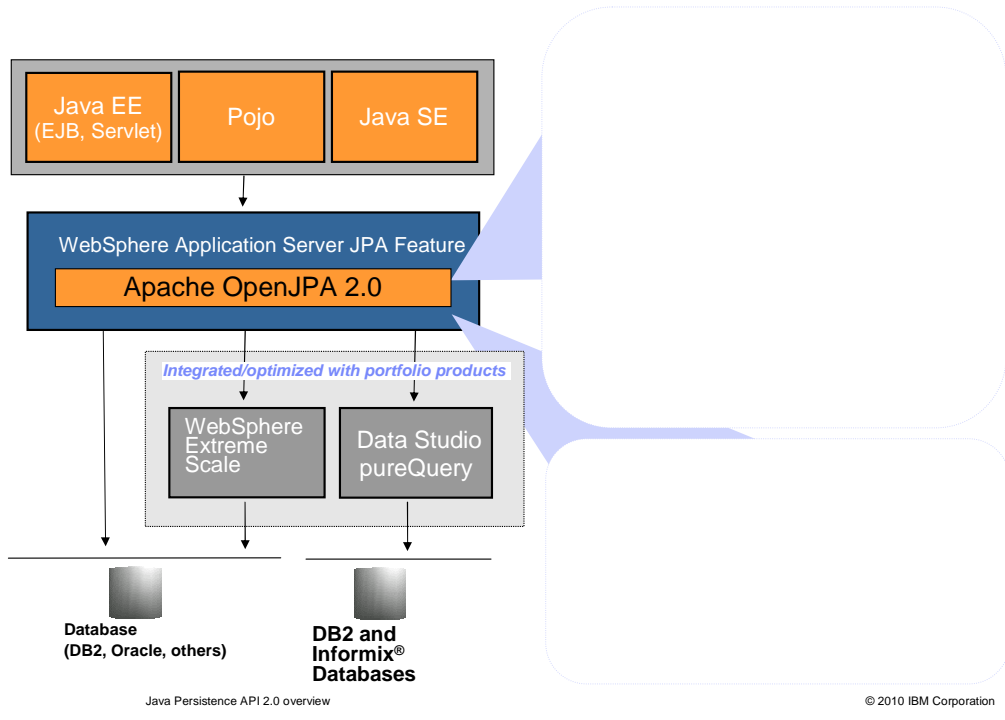


## The WebSphere Application Server V7 Feature Pack for OSGi Applications and Java Persistence API 2.0

- Based on Apache OpenJPA, a leading open source Java persistence framework.
- Provides the Apache OpenJPA 2.0 implementation with IBM enhancements to benefit integration with WebSphere Application Server.
- The Apache OpenJPA 2.0 implementation includes improvements and benefits over previous releases and even beyond the JPA 2.0 specification.

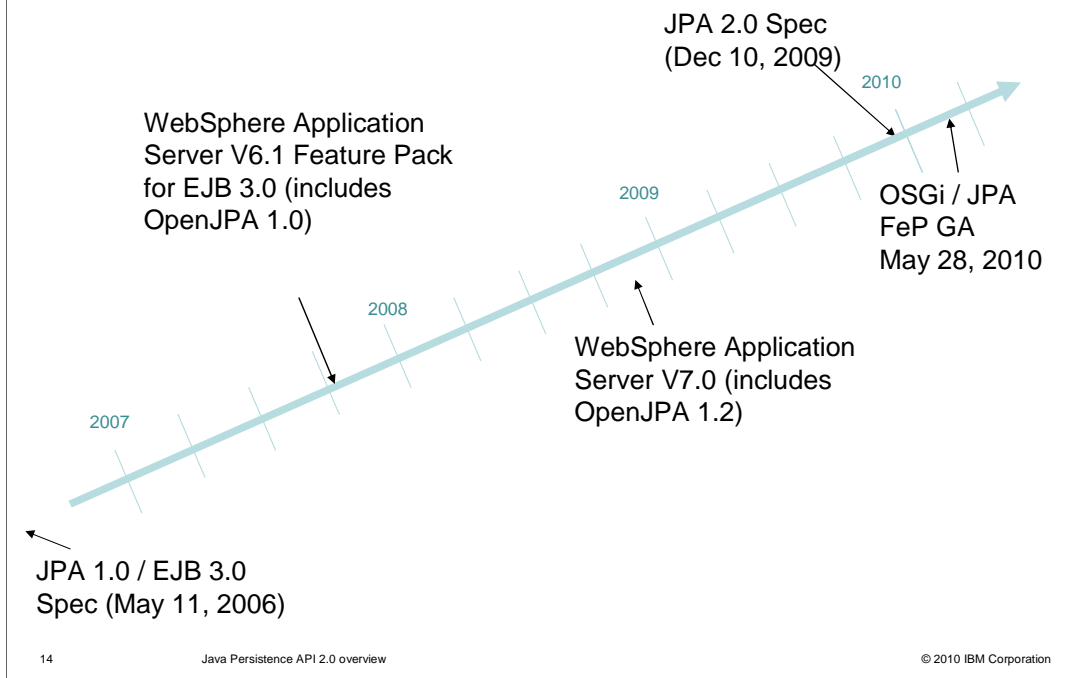
As stated on this chart and as mentioned previously, the JPA2.0 feature in the feature pack is based on Apache OpenJPA.

The majority of the IBM JPA team's development work goes into code that is contributed to the OpenJPA project then extensions are added to make the IBM feature. This means all OpenJPA functionality, extensions and configurations are unaffected by the WebSphere Application Server extensions. Users running OpenJPA applications do not need to make any changes to use their applications in WebSphere Application Server but users who want to use other IBM products and WebSphere Application Server Stack products will benefit from the enhancements made for the feature pack feature as shown on the next slide.



This chart shows pictorially how the JPA feature pack integrates with WebSphere eXtreme Scale and the IBM database products. In addition to working in SE mode and in a Java EE container, JPA can also be used in the OSGi container. The OSGi feature is in the other half of the feature pack that ships JPA.

## WebSphere Application Server V7 Feature Pack for JPA timeline



This chart shows the increased velocity of update of the JPA specifications by WebSphere. As one can see the difference in time between the first JPA specification and the availability of the function in WebSphere was much longer than for JPA 2.0. Considerable effort is being spent to keep customers current with specifications.

## JPA 2.0 highlights

- O/R mapping and domain modeling
  - Embeddables
  - Access types
  - Enhanced map collections
  - Derived identities
  - JPQL updates
- Runtime API updates
  - EntityManagerFactory API, EntityManager API, Query API, Query Result API
- Metamodel and criteria API
- Bean validation
  - Provides entity validation based on JSR-303 semantics

There are many changes to the JPA spec in 2.0. There were considerable improvements in the object relational mapping and domain modeling area. There are also improvements to the runtime APIs providing access to caching capabilities and having additional lock managers available.

JPA 1.0 was only capable of optimistic lock management but JPA 2.0 has the capability to do pessimistic lock management.

One of the big items with JPA 2.0 is the meta-model and criteria APIs that provide a programmatic interface for generating queries so you do not have to rely upon strings of JPQL to do queries. You can do it programmatically and change the various predicates and where clauses that you want to do with your queries.

Bean validation is a separate JSR (JSR-303) but it has tight integration with the JPA 2.0 specification. That capability is provided as well so you can validate your entities before or after they get persisted to the database.

Object-relational persistence is a key developer requirement for many application developer scenarios. JPA is the Java EE standard for object-relational persistence and was first introduced as part of Java EE 5. As part of the Java EE 6 standards, JPA 2.0 (JSR-317) updates object-relational capabilities with important developer APIs and enhancements.

## ***OpenBooks sample program description***

Now for a brief description of the OpenBooks Sample.



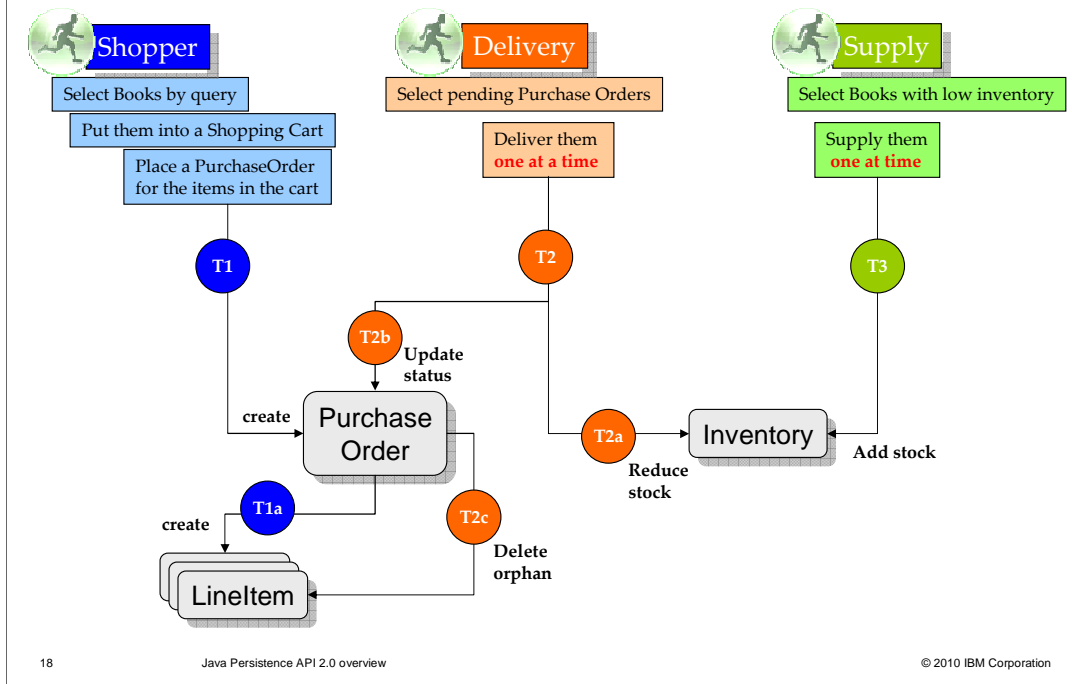
## Overview



- OpenBooks is a sample application based on JPA 2.0
  - Good practices
    - Persistent domain modeling
    - JPA based application development
    - Testability of transactional applications
    - Design patterns to operate within and without container at ease
  - Demonstration of new features of JPA 2.0
  - Available by way of download from OpenJPA site
    - <http://openjpa.apache.org/openbooks-featuring-jpa-20.html>

OpenBooks is a simple shopping cart application. It was created by one of the development team who is a member of the JPA Expert Group an OpenJPA Committer and an OpenJPA Project Management Committee member. It was created to show how to best use the new function and to demonstrate the new features of JPA 2.0. At the time of this writing, the sample is available on the web at the link indicated on the chart. Should it move in the future, find it with the search string: +”OpenJPA” +”OpenBooks” +”Sample”.

## Multithreaded, optimistic transactions in OpenBooks

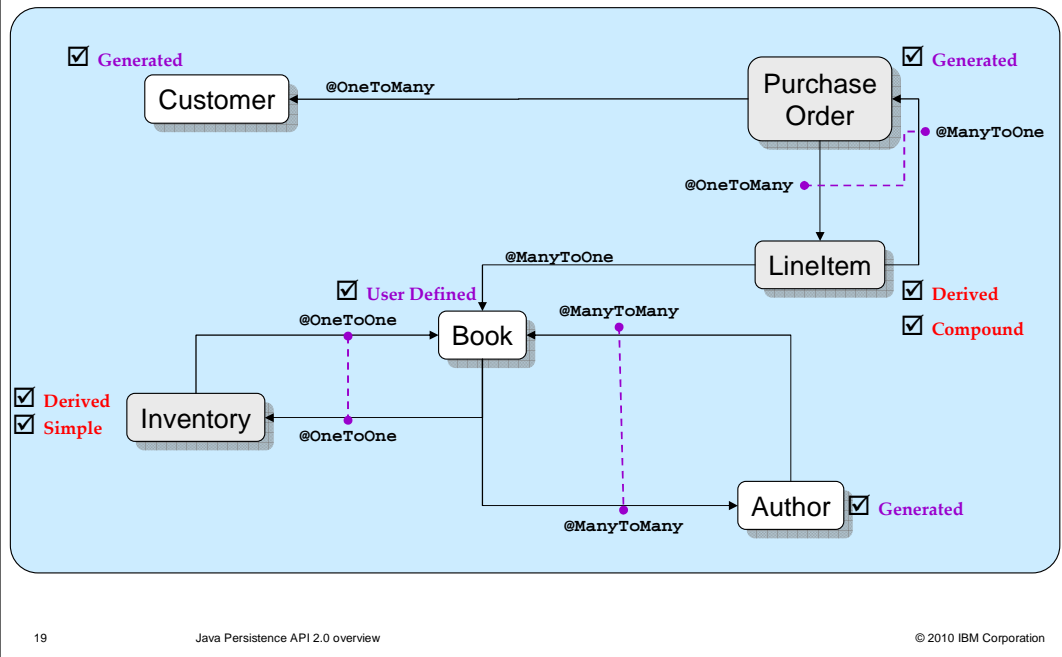


In OpenBooks the shopper selects books, puts them in their shopping cart, and makes a purchase. Then the books are delivered and if that order depletes the supply the supply is replenished.

This chart shows the work flows that are performed by the application. The workflows are select and buy a book, deliver the purchased book, or supply or replenish the inventory

A Shopper browses books, puts them into a shopping cart and eventually purchases them.

## OpenBooks domain model



Here is an overview of the domain model used in the OpenBooks sample program.

There are six entities. Between the entities all of the cases of entity relationships are represented; OneToOne, OneToMany, and ManyToMany.

Also shown in the graphic is the kind of primary key each object has and how it is defined.

## OpenBooks user interface

The screenshot shows the OpenBooks application window with the following components:

- Navigation Panel (Left):**
  - Application Workflows
    - Bookstore/Buy Books
    - Deliver Pending Orders
    - Search Books
  - Views
    - View Configuration
    - View Domain Model
    - View Queries
    - View Services
    - View Source Code
- Search Panel (Top Left):**

Step 1: Search for Books

Title:

Author:

Price: from  to

Criteria Query as SQL:

```
SELECT a
FROM book a
WHERE (a.title LIKE 'book%' AND b.price BETWEEN 100.0 AND 200.0)
```
- Results Panel (Bottom Left):**

Step 2: Select Books to view details

3 Book selected

id	ISBN	version	price	title
1	A7670-22	1	120.611	Book 3
2	03695-41	1	116.728	Book 4
3	57882-31	1	120.584	Book 5
- Shopping Cart Panel (Top Right):**

Step 4: Purchase Books in the Shopping Cart

  - 4 copies of Book 5
  - 2 copies of Book 3
- Shopping Cart Panel (Bottom Right):**

Step 3: Add Book to Shopping Cart

Book 5  
by Author 18  
Price: 120.58400000000000  
ISBN: 57882-31

Quantity:
- SQL Log Panel (Bottom):**

SQL Log | Console

```
SELECT to_id, to_version, to_name FROM Customer to WHERE (to.name = ?)
SELECT to ISBN, to version, to price FROM Book to WHERE (to.title LIKE ? ESCAPE '\') AND to price <= ?
SELECT to ISBN, to version, to price FROM Book to INNER JOIN Book_Author t1 ON to ISBN = t1.BOOKS_SERN INNER JOIN Author t2 ON t1.AUTHORS_ID = t2.id WHERE (to.title LIKE ? ESCAPE '\') AND to price <= ? ORDER BY to ISBN ASC
SELECT to ISBN, to version, to price FROM Book to WHERE (to.title LIKE ? ESCAPE '\') AND to price <= ?
SELECT to ISBN, to version, to price FROM Book to INNER JOIN Book_Author t1 ON to ISBN = t1.BOOKS_SERN INNER JOIN Author t2 ON t1.AUTHORS_ID = t2.id WHERE (to.title LIKE ? ESCAPE '\') AND to price <= ? ORDER BY to ISBN ASC
```

Here is the user interface of the sample. Note that in the panel at the bottom of the window one can observe SQL statements being generated by JPA.

The program uses best programming practices and demonstrates JPA 2.0 capabilities.

## Resources

- Apache OpenJPA code
  - <http://openjpa.apache.org/>
- WebSphere Application Server V7
  - <http://www-01.ibm.com/software/webservers/appserv/was/>
- WebSphere Application Server Feature Pack for OSGi Applications and Java Persistence API 2.0
  - [http://www.ibm.com/services/forms/preLogin.do?lang=en\\_US&source=swg-wsasiposjp](http://www.ibm.com/services/forms/preLogin.do?lang=en_US&source=swg-wsasiposjp)
- WebSphere Application Server V6.1 Feature Pack for EJB 3.0
  - <http://www-1.ibm.com/support/docview.wss?rs=177&uid=swg21287579>
- Blogs
  - <http://webspherepersistence.blogspot.com/>
- White papers
  - [http://www.ibm.com/developerworks/websphere/techjournal/0909\\_col\\_sutter/0909\\_col\\_sutter.html](http://www.ibm.com/developerworks/websphere/techjournal/0909_col_sutter/0909_col_sutter.html)
  - <http://www.ibm.com/developerworks/java/library/j-typesafejpa/>
  - [http://www.ibm.com/developerworks/websphere/techjournal/0712\\_barcia/0712\\_barcia.html](http://www.ibm.com/developerworks/websphere/techjournal/0712_barcia/0712_barcia.html)
  - [http://www.ibm.com/developerworks/websphere/techjournal/0612\\_barcia/0612\\_barcia.html](http://www.ibm.com/developerworks/websphere/techjournal/0612_barcia/0612_barcia.html)
- Books
  - Pro JPA 2: Java Persistence API by Mike Keith and Merrick Schincariol
    - [http://www.amazon.com/s/ref=nb\\_sb\\_noss?url=search-alias%3Dstripbooks&field-keywords=pro+jpa2](http://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Dstripbooks&field-keywords=pro+jpa2)
  - Persistence in the Enterprise, A Guide to Persistence Technologies by Roland Barcia, et al
    - [http://www.amazon.com/Persistence-Enterprise-Guide-Technologies-developerWorks/dp/0131587560/ref=sr\\_1\\_1?ie=UTF8&s=books&qid=1239033026&sr=1-1](http://www.amazon.com/Persistence-Enterprise-Guide-Technologies-developerWorks/dp/0131587560/ref=sr_1_1?ie=UTF8&s=books&qid=1239033026&sr=1-1)

Here are some useful references, particularly if you are just getting started with JPA.

## Summary

- JPA 2.0 is a natural evolution of the popular JPA 1.0 specification
- OpenJPA 2.0.0-beta was the first publicly-available TCK compliant release (after the RI)
- WebSphere Application Server V7 Feature Pack for OSGi Applications and Java Persistence API 2.0 now available!
- Download and experiment with either version.

In summary, JPA 1.0 is already used extensively in the industry and JPA 2.0 is gaining traction.

The OpenJPA 2.0 deliverable from Apache and the WebSphere Application Server Feature Pack for OSGi Applications and Java Persistence API 2.0 are both available.

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